HECC Briefing to the Presidential Advisory Committee on High Performance Computing and Communications, Information Technology, and the Next Generation Internet

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HECC FY 1998 Budget by Agency and Program Activity (1)

NSF		**132.90**
	Applications	28.71
	Supercomputer Centers	53.17
	Computing Systems	51.02
DOE		**90.80**
	Advanced Computational Testing and Simulation Research	33.74
	Grand Challenge Applications	9.00
	DOE2000 ACTS	5.00
	National Energy Research Scientific Computing Center	26.50
	High Performance Computing Resource Providers	16.56
NASA		**90.10**
	Testbeds	24.50
	Grand Challenge Support	48.60
	Systems Software	17.00
DARPA		**84.80**
	Information Sciences	6.00
	System Environments	12.70
	Scalable Systems and Software	35.20
	Microsystems	15.90
	Embeddable Systems	15.00

HECC FY 1998 Budget by Agency and Program Activity (2)

NSA		**26.42**
	Supercomputing Research	24.20
	Superconducting Research	2.22
NIH		**23.74**
	NCRR Biomolecular Computing	6.30
	NCRR Software Tools for Receptor-Based Drug Design	2.20
	NCRR Modeling/Simulation	4.50
	DCRT High Performance Biomedical Computing Program	6.12
	NCI Frederick Biomedical Supercomputing Center	3.91
	NCI High Speed Networking and Distributed Conferencing	0.20
	NIGMS HPCC Extramural Activities	0.51
EPA		**5.38**
	Environmental Modeling	2.25
	Computational Techniques	3.13
NOAA		**4.30**
	Advanced Computation	4.30
NIST		**3.99**
	Information Technology Metrology, Testing and Applications	3.99

HECC Thrusts

1. **System software technology**

   Major improvements in usability and effectiveness of TeraFLOPS-scale systems across a wide range of government, industry and academic applications.

2. **Leading-edge research for future generations computing**

   Research and technology necessary for PetaFLOPS-level computation & exabyte-level mass storage.

3. **Incorporation of technology into real applications**

   First use of HECC technologies in agency applications, develop use of computational science algorithms for solutions requiring high performance computational facilities. Ensure key applications will execute at full potential.

4. **Infrastructure for research in HECC**

   Advance full potential of research computational facilities, large-scale test systems and high performance computational grid and large scale networks by fostering a balanced, high capacity, state-of-the-art HEC infrastructure.

HECC FY 1998 Budget ($, M) by Agency and HECC Thrust

Agency	Thrust 1	Thrust 2	Thrust 3	Thrust 4	HECC Total
NSF	31.00	20.02	28.71	53.17	132.90
DOE	0.00	0.00	47.74	43.06	90.80
NASA	17.00	0.00	48.60	24.50	90.10
DARPA	33.70	51.10	0.00	0.00	84.80
NSA	1.00	24.42	1.00	0.00	26.42
NIH	0.00	0.00	13.71	10.03	23.74
EPA	3.13	0.00	2.25	0.00	5.38
NOAA	0.00	0.00	0.00	4.30	4.30
NIST	3.99	0.00	0.00	0.00	3.99
Total	89.82	95.54	142.01	135.06	**462.43**

HECC 1998 Milestones

- Demonstrate 256-component addressed array of molecular computational mechanisms and a computational paradigm mechanism in an engineered living cell; evaluate surface patterning mechanisms for culturing neural components on silicon.
- Demonstrate order of magnitude improvement in operating systems/network interface of translucent system and LAN-based quality-of-service performance assurance for Quorum Prototype No. 1.
- Demonstrate scalability beyond 128 nodes of parallel design environment, scalable, parallel-processing, and symbolic simulation linked with hardware emulation for complex system design.
- Demonstrate order of magnitude reduction in design time with experimental scalable application versions of new iterative solvers for radar cross-section modeling, languages and runtime services supporting parallel applications such as Advanced Distributed Simulation, and HPC++ languages and runtime services supporting both task and data parallelism.
- Demonstrate symbolic simulation linked with hardware emulation for complex design technology.
- Complete the experimental evaluation of design technology for high performance computational prototyping of systems, supporting both task and data parallelism for scalable software library technology.
- Demonstrate a computational model using UltraScale computing techniques.
- Demonstrate integrating testbed architecture incorporating advanced distributed simulation, advanced distributed collaboration, advanced communications and control, and advanced human computer interfaces.
- Demonstrate initial capabilities of intelligent information services architecture with multiple mechanisms for describing resource capabilities and with a uniform interface to hybrid search methods for resource retrieval
- Demonstrate portable scalable programming and runtime environment for Grand Challenge applications on a TeraFLOPS scalable system.

HECC 1998 Milestones (concluded)

- Demonstrate interim progress towards FY 1999 objective to demonstrate 200-fold improvements over FY 1992 baseline in time to solution for Grand Challenge applications on TeraFLOPS testbeds .
- Demonstrate the utility of novel protein potential functions to provide the accuracy required for applications in the biotechnology industry, such as synthesizing models of protein receptors for structure-based drug design.
- Complete and distribute algorithms and associated software to: (1) predict the folded structure of proteins, (2) select from the small molecule database inhibitors for therapeutically important enzymes and receptors, and (3) determine the structure of biological macromolecules up to 1,600 atoms by direct methods.
- Demonstrate the impact of advanced packaging techniques to greatly decrease the size and weight (by up to a factor of 4) of a commercial high performance computer.
- Create a prototype for a powerful, mobile, front-end processor that supports high capacity I/O, high performance computing, high utilization of peak processor performance (50-80%), and is programmable in a high level language (such as C, C++).
- Research is directed at developing a multi-gigabit per second crossbar switch for supercomputer and data transfer applications. This work is to demonstrate a 128x128 crossbar switch with 2.5Gb/s per port data rate and a latency less than 10ns. The device technology is cryogenic superconductive digital circuits. The final system components will be selected and assembly begun during FY97 and continue through FY 98 for an FY 99 delivery of:
  - an operational 128 X 128 superconductive crossbar switch;
  - a 100 Gb/s serial to parallel device with clock recovery; and
  - two types of 16Kb subnanosecond access-time memory chips-one room temperature, and one superconductive

Setting the HECC R&D Agenda

Vision and Needs Identification Strategy

- **Vision**
  - Maintain U.S. leadership in high end computing and computation (HECC)
  - Promote effective use of HECC for government, industry, academic, and broad societal applications
- **Strategy**
  - Develop HECC R&D agenda with strong input from community
  - Coordinate agency programs through CIC R&D process
  - Solicit Industry perspective, exchanging needs and plans
  - Support spectrum of activities from research to mission-driven
  - Promote jointly-funded, jointly-managed projects
  - Sustain on-going agency investments, especially in Applications and Infrastructure, and pursue new augmentations in high priority areas
  - Assign agencies to assume lead roles for specific, focused HECC efforts

Setting the HECC R&D Agenda

HECC Community Activities

- Santa Fe Workshop on Parallel Computer Systems: Software Performance Tools (October, 1991)
- First Pasadena Workshop on System Software and Tools for HPC Environments (April, 1992)
- Keystone Workshop on Software Tools for Parallel Computing Systems: A Dialogue Between Users and Developers (April, 1993)
- Workshop and Conference on Grand Challenges Applications and Software Technology (May, 1993)
- Workshop on Enabling Technologies for PetaFLOPS Computing Systems (February, 1994)
- Second Pasadena Workshop on System Software and Tools for HPC Environments (January, 1995)
- PetaFLOPS Summer Study on Application Software (August, 1995)
- PetaFLOPS Architecture Workshop (April, 1996)
- Workshop on Software Tools for HPC Systems, Cape Cod, MA (October 1996) Petasoft Workshop (June, 1996) and PetaFLOPS Software Framework Model (January, 1997)
- PetaFLOPS Algorithm Workshop (April, 1997)

Setting the HECC R&D Agenda

Coordinate Agency Programs

- Monthly HECCWG meetings
- Joint program activities
- Annual Implementation Plan
- Periodic reviews and reporting
- National Security Community Integrated Process Team Study - Fall, 1996
- HECC Program Strategy, a living document:
  - Presents current activities of agency HECC programs and multi-agency collaborations
  - Details technical goals and approach in four major Thrust areas
  - Highlights needs not currently accommodated

HECC Private Sector Roles

- Assessing Private Sector delivery prospects
  - Non-disclosure discussions (~annually)
  - Continuing dialog at technical levels
- Liaison with Industry
  - Inclusion of industry in symposia, conferences, and workshops
  - Test and evaluate new industry offerings
  - Work with industry to commercialize research investment successes
- Articulate Federal needs in public forum
  - Solicit public support (e.g. PAC)
  - Reports
  - Conferences (e.g. annual Super Computing conference)
  - Formal specifications and solicitations

HECC Agency Roles

- Agencies decide what work their agency will do
  - Funding and responsibility at agency level
  - Best qualified to determine how to spend agency funds
  - Most knowledgeable of specific task assignments and potential to share work of others
- Agency HECC roles
  - Actively support and participate in HECCWG activities
  - Offer candidate projects/programs for collaborative efforts
  - Accept and responsively lead effort, where appropriate
- Decisions heavily affected by agency funding mechanisms
  - HECC Thrust definitions focus traditional areas of contribution:
    - System software technology
    - Leading-edge research for future generations computing
    - Incorporation of technology into real applications
    - Infrastructure for research in HECC

HECC Current Multiagency Work

Thrust 1: (Task Force, Johnson)	
• Software Exchange	NASA, DARPA, DOE, DOD Mod., NSA, NIST, EPA, NSF
• Scalable I/O Initiative	NASA, DOE, DARPA, NSF
• Language standards (e.g. HPF, MPI)	NASA, NSF, DARPA, DOE
• Joint BAA's	NSF, DARPA
• Compiler Consortium	NSA, DARPA
Thrust 2: (Task Force, Bailey)	
• Architecture Point Designs	NSF, DARPA, NASA, DOD Mod.
• Tera MT architecture evaluation	NSF, DOE, NSA
• Hybrid Technology / Multi-Threaded Architecture	NSA, DARPA, NASA
• Algorithms Point Designs	NSF, DARPA, NASA
• PetaFLOPS Workshops	DOE, NASA, NSF, DARPA, NSA
Thrust 3: (Kitchens, Novak, Turnbull)	
• Participate on each others competitive selections to strengthen collaboration	ALL
• Partner on applications when similar	ALL
Thrust 4: (Borchers)	
• Computational research facilities justified on single Agency needs - may grow capability to meet multi-Agency needs	DOE, NSF, NASA, NOAA, DOD Mod.

HECC Multiagency Work

- Mutual interest
- Synergism
- Critical mass

Explore joint program management mechanisms as required

HECC - Issue of Overlap

- Funding of similar activities sometimes beneficial
- Reduce/eliminate unnecessary overlap by:
  - Working within the same community area on continuing basis
  - Publications
    - Annual Implementation Plan
    - Annual Blue Book
  - Forums
    - Semi-annual Budget and Program review and assessments
    - Agency representatives serving on other Agency proposal committees

Major HECC Concerns

- Industry may not meet Federal High End Computing requirements
  - Many companies tried and failed
  - Business case targeting more lucrative mid-range market
  - Progress not keeping pace with Federal needs
- High End R&D is drying up
  - Declining industry R&D resource investment
  - Flow from Federal and Academic research sectors weak
  - Less innovative ideas and novel approaches
- Intense competition from Japan for HEC market share
- Critical, time-sensitive needs not sufficiently articulated
  - HECC lacks momentum for funding high priority HECC endeavors
  - **Need PAC help to raise awareness**

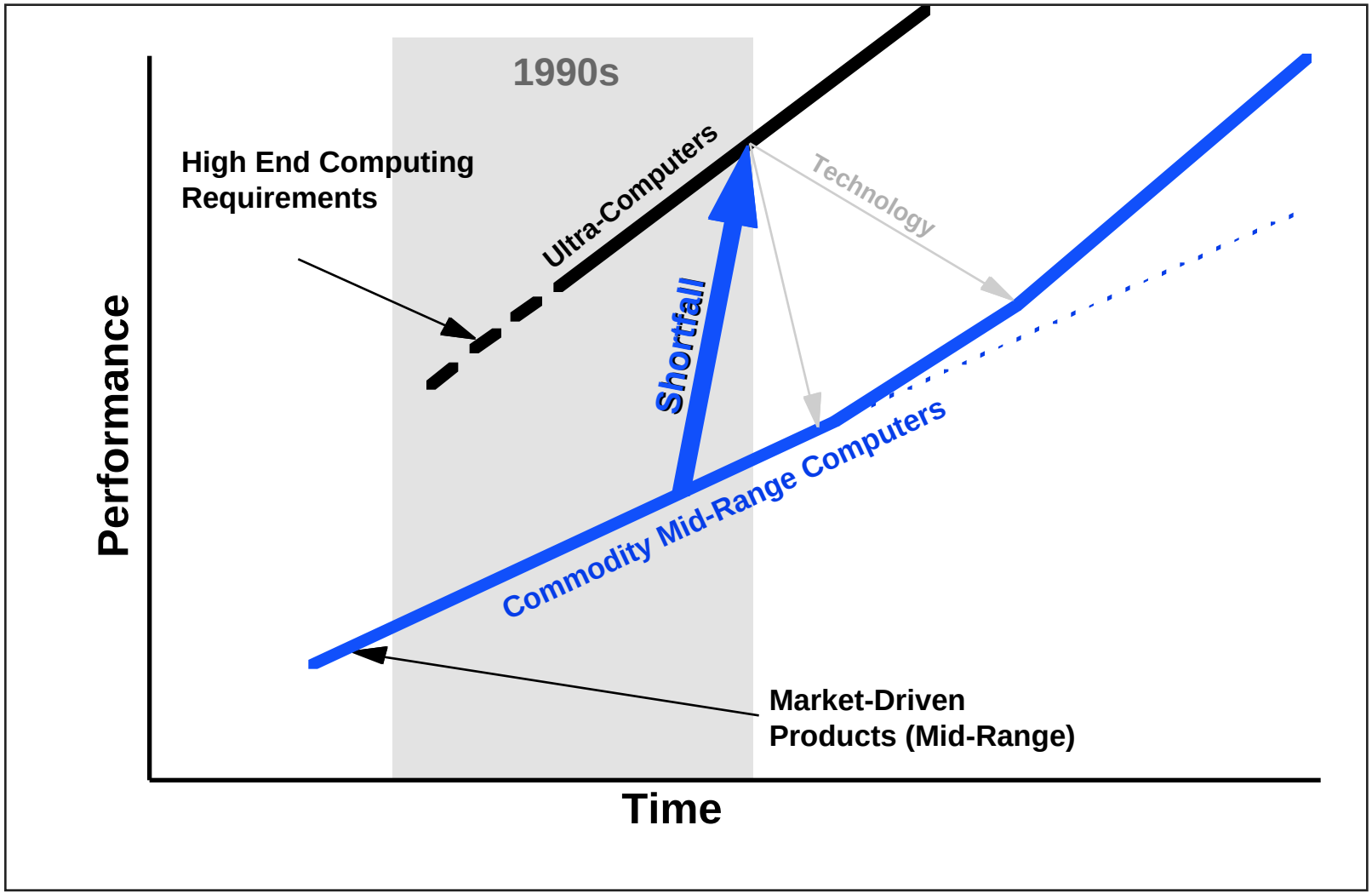
Major HECC Concerns (concluded)

HECC lacks momentum for funding high priority HECC endeavors:

- Thrust 1, System software, needs $30M-$40M program adjustment
- Thrust 2, Leading-edge research, suffers an estimated $80M-$130M shortfall
- Thrust 4, Infrastructure for research, is heavily dependent on LSN/NGI for expanded collaboration and the Computational Grid

Backup charts
(Supplemental Information)

HEC Private Sector Lagging



HEC US Private Sector Declining

Three Survivors Shipping Product: - Only one with technical high end commitment

Tried and Failed	*Recent High End Failures*
Alliant	CCC
BBN	Intel (SSD)
CDC	Kendall Square
Denelcor	Maspar
Elxsi	TMC
ETA	NCube
FPS	
Goodyear	
Multiflow	
Myrias (Canada)	
Prime	
SCS	
Sequent	
SSI	

Mergers	*Others*
SGI- CRI	IBM
Hp/Convex	TERA

Survivors Shipping Product

* **Japanese making major national strategic investments**
* **US firms and capital abandoning high end market**

Briefing to PAC, June 24, 1996: High End Computing for National Security - Conclusions of an Integrated Process Team